Question	Answer
My question is to Ryan. Do you see the future where controls of inverter-based resources are standardized, same as synchronous generators. This will reduce the variety of controls and few number of models can be used to really understand different dynamic problems like control instability and resonance.	NERC Reliability Guideline on BPS-Connected Inverter-Based Resource Performance and IEEE P2800 activities are seeking to standardize performance (not specific controls) of BPS-connected inverter-based resources.
To Ryan, does NERC has requirement as to which EMT software (EMTP, PSCAD, or RTDS) has to be used in EMT study?	No. All NERC standards are technology agnostic, including the use of specific software/hardware.
Limitations of RMS simulations were touched upon. Are there limitations to doing EMT simulations?	Answered in Q&A
Should EMT modeling and analysis become a fall-back option to safeguard against due diligence not being carried out in RMS model development and parameterization?	Answered in Q&A
Hey Bob. A V-behind-Z model for rms positive sequence representation is in the works already and software vendors have implemented beta versions.	Thank you for your comment.
Are there any guidelines to alert the user that the RMS simulation results are not reliable and EMT is required? Can it be based on system strength, penetration of converter-based generation resouces, others?	The rms positive sequence stability simulations will start to give suspicious results in many (but not all) cases. This leads the engineer to needing EMT simulations. However, SCR-based metrics can also be used as a screening tool to identify areas where these issues may be more prominent (prior to detailed studies), and those metrics may be useful for helping determine when EMT simulations may be needed. See the NERC Reliability Guideline: Integrating Inverter-Based Resources to Low Short Circuit Strength Conditions.
Should we, as an industry, be asking for "true code" models for EMT work instead of allowing vendors to take shortcuts in their modeling work? Thoughts . . .	Yes, from what I have seen and experienced thus far, "real code" EMT models are likely a very positive path forward. Grid planners and operators need absolute assurance that they understand how BPS-connected inverter-based resources perform.
Hi, this is Brian from AEMO, Australia. Do TSOs in North America propose control settings for IBR based on outcomes of interconnection studies? Or do they do studies using models provided as it is and derive conclusions out of that?	Answered in Q&A

What is the challenge in sourcing site specific models (ie models from OEM tuned for that particular site) for IBR prior to interconnection studies?	Inverter and plant controller settings may not be known. Actual type/model of inverter may not be fully defined. Therefore, this information may not be available to the developer of generator owner at this early in the interconnection process.
Without explicit requirement from NERC in form of a standard, how can TO/TP force PV plant owners and developers to provide details of the control settings updates and acceptable models ? EMTP models are even more difficult to obtain despite asking upfront	FAC-001-3 requires each TO to have interconnection requirements, developed at the discretion of the TO, to address ANY needed issues. These requirements should be kept up-to-date to address the changing resource mix, including ensuring tha the requirements cover needed improvements to the modeling and study activities. Do not rely on NERC Standards for this level of detail. Utilize the requirements that you set forth for interconnection, and then enforce said requiremetns when they are not met.
Excellent presentations. Thank you.	Thank you for your comment.
Can i ask which one grid following or grid forming IBRs can be used for black start? Also, when is momentary cessation a good thing and how do you model the cases when you want the IBR to stop injecting power to the system and when we want to run through?	Answered in Q&A
Do you think grid-forming converters might also face converter-level instability, particularly DC-link instability due to system strength issues? Because you know that the active power and reactive power change very fast in low system strength grid.	Yes, any inverter with a limited DC link energy source will need to consider stability of the DC side voltage. Allowing rapid changes in current flow may drain the energy device, and will need to be considered by OEMs in their design, settings, and protection. However, these should NOT preclude the resource from providing essential reliability services within the ride-through operating ranges or other modes of operation.
What kind of instability grid-forming converters might face? Is there going to be any converter-level instability like DC-link instability for them?	See comment above.
We have been seeing a lot of issues with fault response in various generations of WECC Gen 2 models including crashes and voltage overshoots to the point that some TO/TPs have requested the user-defined models. Is there any working groups looking at these scenarios especially with manufacturers as they supply the models to owners?	The WECC REMTF and NERC IRPTF are looking at these issues. The model crashing issues should be analyzed with care, and both issues are likely due to incorrect parameterization of the dynamic models rather than the models themselves. I recommend getting involved with the NERC IRPTF.

This is Wei Du from PNNL. I have a question on fault current injection. During a fault a synchronous generator injects high fault currents. Do you think if we should require inverters to inject high short currents during faults in the future?	This is likely infeasible without significant expense. Conversely, what is the need for high fault current? Relay manufacturers, and work performed by DOE-funded projects, have shown that the magnitude of fault current is LESS critical than the correct phase relationship of V1/I1 and V2/I2 during on-fault conditions.
Hi Ryan, we had a benchmarking excercise for a wind interconnect in ISO NE in 2017. Should we be expecting more in the future? Will a guideline be published soon?	Answered in Q&A
phasor mode and discrete mode of simulation..what is the difference?	The rms positive sequence simulation tools use simplifying assumptions due to the time step and positive sequence nature of the simulations. On the other hand, EMT models use very small timesteps and capture much more of the switching dynamics and components in the model.
Question for Ryan: What is the data requirement for the diturbance based model validation of the inverter ? is PMU good enough ? Or do we have to DFR or Point on Wave data ?	Experience analyzing BPS disturbance events have shown that PMU data is NOT sufficient to capture the response of the overall inverter-based resource. Refer to the NERC Reliability Guideline: BPS-Connected Inverter-Based Resource Performance for details on the recommended data sources for inverter-based resources. These include inverter-level recordings, PMUs at the point of interconnection, DFR capability at the point of interconnection, sequence of events recording throughout the plant, and all time synchronized to at least 1 ms resolution.
What is the performance of the models with respect to SSR?	The rms positive sequence models may not capture SSR/SSCI and may require additional, more detailed studies like EMT where these frequency ranges can be picked up and the models may capture these interactions.